



Materials and Coatings

Functionalization of Single-Wall Carbon Nanotubes

A new technique for carbon nanotube oxidation

A new technique for carbon nanotube oxidation based upon the photo-oxidation of organic compounds was developed by NASA's Glenn Research Center. Single-wall carbon nanotubes (SWCNTs) have a nearly fivefold higher Young's modulus, a tenfold higher tensile strength, and three times the elongation at break of conventional carbon fibers. In addition, they have electrical and thermal conductivities that are nearly ten times that of high conductivity carbon fibers. Use of SWCNTs as additives to polymers has been shown to significantly increase their mechanical, electrical, and thermal properties. Functionalization of single-wall carbon nanotubes improves their ability to be incorporated into polymer matrices and enhances their bonding with the matrix. NASA Glenn's new technique for carbon nanotube oxidation was developed upon the photo-oxidation of organic compounds. The resulting method is more benign than conventional oxidation approaches and produces SWCNTs with higher levels of oxidation.

BENEFITS

- Better oxidation: Oxidation levels using this method are nearly twice that obtained by conventional oxidation
- Safer: Does not require the use of toxic oxidizing agents or corrosive acids

technology solution



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THE TECHNOLOGY

In Glenn's technique, SWCNTs are dispersed in a suitable solvent, such as N-methyl pyrrolidinone, and the resulting suspension is saturated with oxygen gas. A singlet oxygen sensitizer is added and the resulting mixture is irradiated under a continuous flow of oxygen for many hours. The resulting oxidized tubes are recovered by filtering the suspension, washing them, and then drying them in a vacuum oven. Singlet oxygen is a highly reactive species and is known to add to a variety of aromatic carbons. Singlet oxygen is prepared by irradiating an oxygen saturated solution with ultraviolet light in the presence of a sensitizer. This method may also be suitable for use in oxidation of multi-wall carbon nanotubes and graphenes.

This is an early-stage technology requiring additional development. Glenn welcomes co-development opportunities.



Single-wall carbon nanotubes may be used in composite materials for sporting goods

APPLICATIONS

The technology has several potential applications:

- Aircraft structures to mitigate lightning strikes
- Lightweight materials for automotive applications
- Composite materials for sporting goods

PUBLICATIONS

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National Aeronautics and Space Administration

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